SOME OBSERVATIONS ON THE EFFECTS PRODUCED ON THE SKIN BY THE DISCHARGE OF SMALL-ARMS LOADED WITH SMOKELESS POWDER.[1]

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THE effects upon the skin produced by the discharge of small-arms loaded with black gunpowder at close range have often been studied.

The subject is of especial interest from a medicolegal point of view. Not all the grains of black powder in the charge are burned in the barrel of the weapon, and the unburned grains or partly burned grains are propelled with some force for a distance of several feet.

If these strike the human skin or the clothing certain effects will be produced, which will vary according to the weapon used, the size of the powder charge, and the distance of the muzzle from the skin or the clothing, as the case may be.

With a given weapon and a given charge of powder, it may be possible to determine from the character of these effects whether a shot has been fired within a certain distance or not. The important bearing of such data upon the judicial verdict in certain cases of murder or suicide is obvious, and evidence so derived has in many instances been of great use in the furtherance of justice.

The effects produced by black powder upon the skin are in the nature of tattoo marks, that is to say, the grains of powder are driven into the substance of the skin. The area thus marked increases with the distance at which the shot was fired, whereas the number of grains embedded diminishes with the distance. Such tattooing may, it is said, occur at a distance of at least ten feet.

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The hair of the scalp may be singed at a distance of three feet by the discharge of an ordinary .32-caliber revolver.

Clothing may be scorched by the discharge at a distance of several feet, and at a range of a foot or less linen may be set on fire.

The effects of black powder, then, are obvious and, within certain limits, fairly definite.

It occurred to me that some experiments to determine whether other or similar effects were produced by the discharge of pistols loaded with smokeless powder might not be devoid of interest.

There are at present several kinds of pistols on the market using smokeless ammunition exclusively. It seems therefore not improbable that in the future homicides and suicides will largely be committed with weapons using ammunition of this class.

Smokeless powders have gun-cotton as a basis, to which is sometimes added a small amount of nitroglycerin, or one or more of a large number of ingredients both organic and inorganic. The purpose of these additions is to modify the character of the ignition or of the explosion, or to give the powder a distinctive color or to make it waterproof. The grains of such powders are usually small and of various shapes.

The explosion of black powder gives on the average 65 per cent. solid residue and 35 per cent. of usable gases. Smokeless powders give on the other hand nearly 70 per cent. of usable gases and 30 per cent. of solid residue.

Smokeless powder is at least twice the strength of black powder weight for weight; some kinds are much stronger. Accordingly, the amount of residue of smokeless powder driven from the gun is much less than is the case with black. The combustion of smokeless powders is, in other words, much more complete.

The circumstances under which my experiments were conducted led me to omit, for prudential reasons, the use of high-powered rifles, and to use only pistols and a shotgun. Through the kindness of Dr. J. C. Ayer, I was able to experiment with four pistols,—Colt's automatic pistol, caliber .32; Colt's automatic pistol, caliber .38; the Luger automatic pistol, caliber 7.65 millimeters; the Mauser repeating pistol, caliber 7.63 millimetres: these latter two are of German manufacture.

For comparison, a black powder .32-caliber Hopkins and Allen revolver was used, firing Smith and Wesson ammunition.

The shotgun used was a 12-gauge Parker gun, what is known as a close shooting-gun.

For the purpose of testing the effects of the discharges upon the skin, the body of a medium-sized man was procured. The cadaver was quite recent, the skin showed no signs of decomposition, the muscles felt quite firm. Rigor mortis was absent.

In addition to notes on the effect produced upon the skin, some observations were made on the penetration of the different pistols. Lastly, a number of shots were fired from a shotgun to determine the character of the wounds produced at different ranges.

SHOT I.—Colt's automatic pistol, caliber, .32 inch.; smokeless powder; charge, four grains Walsrode powder; bullet, lead, full copper mantle; weight, seventy-six grains. Distance of muzzle of pistol from skin two inches. Shot fired at the side of the head in front of the ear, skin covered with short hair. The hair was not singed. The skin was not burned. A few grains of a dark gray residue were found upon the hair and upon the skin over an area one inch in diameter surrounding the bullet wound. These grains were readily wiped off with a dry cloth, leaving no visible mark behind.

The wound of entrance in the scalp was a small, circular orifice one-sixteenth of an inch in diameter. There was no discoloration of the edges apparent, nor were the edges frayed.

The wound at the point of entrance in the skull was found to be a round hole through the bone about the diameter of the bullet.

The wound of exit from the scalp upon the opposite side of the head back of the ear was a mere slit in the skin one-fourth of an inch in length.

The wound of exit from the skull was a round hole about the diameter of the bullet. The bullet failed to penetrate the barrel of sand used as a backing, and was picked up off the floor but slightly deformed.

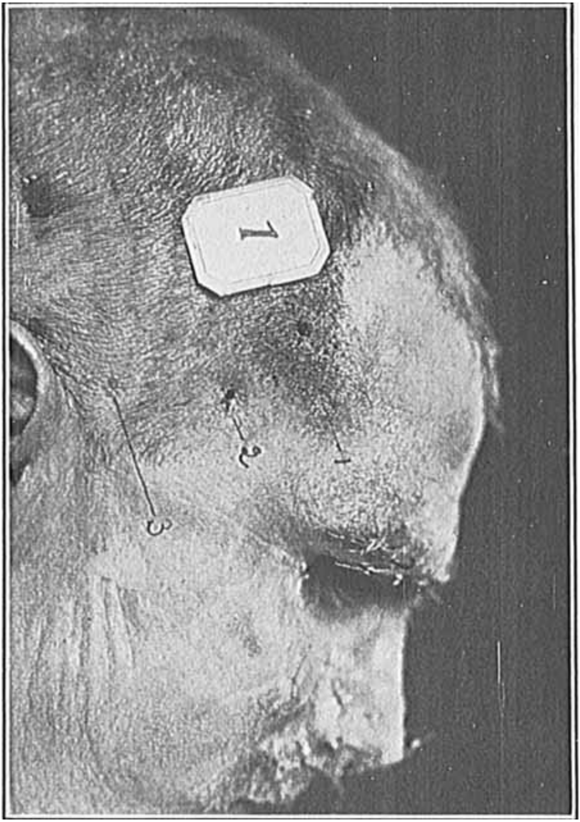

FIG. 1.—Three shots. From before backward. .32, black powder. .38, Colt, smokeless. .32. Colt, smokeless.

SHOT 2.—Colt's automatic pistol, .38-caliber; soft-nosed copper jacketed leaden bullet, smokeless powder (seven grains Walsrode?); bullet, 130 grains. *Was fired into temporal region of the skull at a distance of* two inches. Wound of entrance a round orifice in the skin one-eighth of an inch in diameter. Edges of wound slightly contused. A few faint lead-colored stains upon the skin surrounding the wound. These specks appear to be embedded in the skin, and cannot be removed by rubbing with a wet cloth. The hole of entrance through the skull is round and about the diameter of the bullet.

The wound of exit in the skin upon the opposite side of the head is an irregular tear about one inch in length, with radiating slits along its border. Brain substance escaped freely from this orifice as well as from the external auditory canal on the same side of the head. Palpation of the skull showed a comminuted fracture surrounding the wound of exit. The comminution of the skull extended over an area three inches in diameter in the temporal and parietal regions. There was doubtless also present an extensive fracture of the base of the skull. After leaving the head, the bullet buried itself in a barrel of sand.

SHOT 3.—For purposes of comparison, a shot was now fired from a Hopkins and Allen revolver, caliber, .32 inch.; Smith and Wesson ammunition; black powder, ten grains, soft lead bullet. The shot was fired into the temporal region with the muzzle of the pistol three inches from the scalp.

The hair was singed, the scalp was burned and tattooed with powder grains, so that the skin was black over an area one and one-half inches in diameter. The wound of entrance in the skin was one-eighth of an inch in diameter, the edges were slightly contused and stained lead color. The hole in the skull was about the diameter of the bullet. Bullet lodged.

Photograph No. 1 is a picture of these three shots. From before backward. 1, .32, black powder; 2, .38, Colt, smokeless; 3, .32, Colt. smokeless.

SHOT 4.—Luger automatic pistol, 7.65 millimetres caliber; steel jacketed bullet. Jacket incomplete over a small circular area at the point of bullet where the lead interior is exposed. Powder charge, five grains, smokeless.

Shot fired into the cheek over malar bone backward, downward, and inward. Distance, three inches. No powder marks upon the skin. Orifice of entrance three-sixteenths of an inch in diameter and circular. Edges slightly contused and white in color. Bullet lodged.

SHOT 5.—Mauser automatic pistol, caliber, 7.63 millimetres; steel jacketed bullet. Shot fired at outer aspect of upper third of right thigh. Distance of muzzle of pistol from skin three and one-half inches. Powder stain one inch in diameter. A grayish smudge upon the skin without deposition of distinct grains.

Wound of entrance circular, three-sixteenths of an inch in diameter. Edges slightly contused, white in color; wound of exit on inner surface of limb, oval, three-sixteenths of an inch in diameter, slightly ragged. Wound of entrance on inner aspect of left thigh the same. Wound of exit on outer aspect the same. The bullet then passed through the distal phalanx of left thumb and entered the barrel of sand.

Although the bullet passed through the centre of both limbs, neither femur was fractured.

SHOT 6.—Mauser pistol. Fired into upper third of right thigh at a distance of one foot from the skin. Full jacketed bullet.

A few black specks or grains are adherent to the skin around the wound over an area three inches in diameter. These are readily wiped off with a dry cloth. The bullet caused a fracture of the right femur, and passed across the body in a slightly upward direction, and was found under the skin just above the left great trochanter. The bullet was somewhat deformed as shown.

SHOT 7.—Hopkins and Allen, .32 caliber; Smith and Wesson black powder ammunition. Fired at outer aspect of right thigh; distance, one foot. Skin tattooed with powder grains too numerous to count over an area three and one-half inches in diameter. Wound of entrance circular, three-sixteenths of an inch in diameter; edges stained with lead. Bullet lodged.

Inasmuch as the changes produced in the skin by the smokeless powders were found to be so slight even at very short distances, it was thought useless to fire shots at greater ranges.

The only shots producing stains which could not be wiped away were the Colt .38, which produced a small and barely perceptible smudge upon the scalp at a distance of three inches, and the Mauser pistol, which produced a slightly more perceptible smudge at the same distance. At one foot none of the shots left any permanent powder marks upon the skin.

Photograph No. 2 is a picture of two shots fired into the thigh with the Mauser pistol at one foot, and three inches, respectively.

Photograph No. 3 is a picture intended to show the different effects of a .32-caliber revolver loaded with black powder, and the Mauser pistol loaded with smokeless powder, each at a distance of one foot.

Some shots were then fired with a 12 gauge Parker shotgun, loaded with bird-shot and smokeless powders, to determine the character of the wounds produced at different distances, more especially to note how far the charge of shot continued to act wholly or in part as a single missile.

The subject was suspended by the head in the erect posture and all the shots but one were fired from in front. The thickness of the body through the abdomen from before backward was eight and one-half inches.

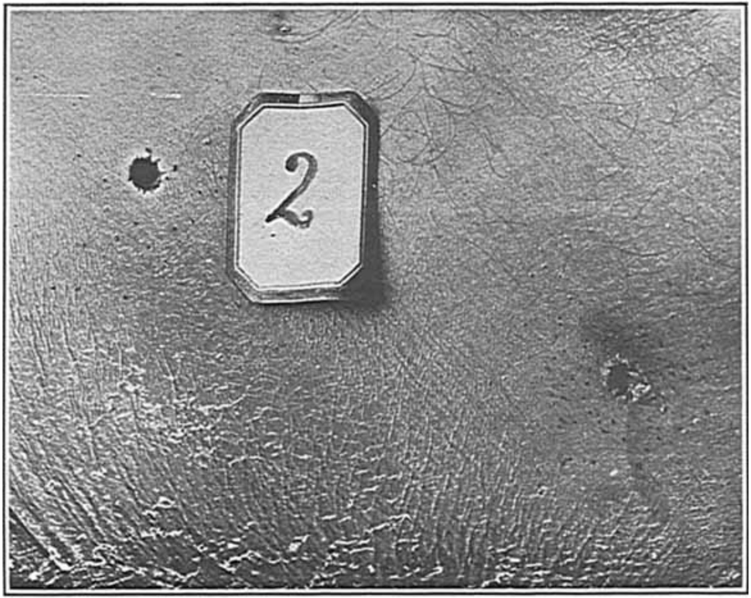

FIG. 2.—Two shots fired into the thigh with the Mauser pistol at one foot, and three inches, respectively.

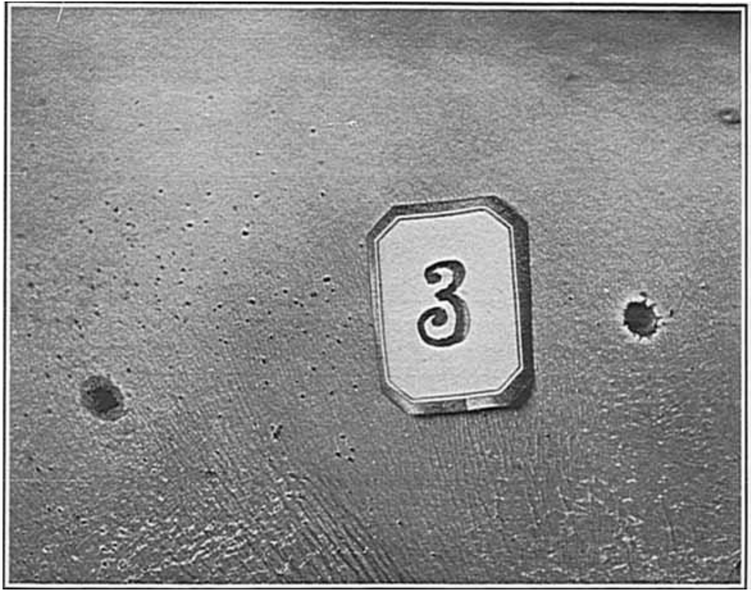

FIG. 3.—.32 caliber revolver, black powder, at one foot, showing tattoo marks. Mauser pistol, smokeless powder, at one foot; absence of tattoo marks.

Shot 1.—Shell loaded with thirty-seven grains Dupont smokeless powder, said to be the equivalent of three drachms of black powder, one and one-eighth ounce No. 4 shot. Shot fired at the umbilical region. Distance, eighteen feet. Spread of shot, three and one-half inches. In the centre a ragged hole two inches in diameter was torn through the abdominal wall. There is a distinct bulging in the back, forming a soft tumor nearly in the middle line, and individual shot can be felt embedded in the skin of the back over this area.

Shot 2.—Same load; distance, thirty-five feet. Shot fired at epigastrium. Spread of shot over an area seven inches in diameter. Shot wounds discrete, except in the centre, where there is a ragged hole one inch in diameter through the abdominal wall. In this hole there lies embedded a powder wad. Shot did not emerge from back.

Shot 3.—Cartridge loaded with twenty-four grains Ballistite smokeless powder; said to be equivalent to two and three-fourths drachms of back powder; one and one-eighth ounce No. 9 shot; distance, eighteen feet.

Shot fired at lower part of abdominal wall on the left of median line. Spread of shot six by six inches. There is a ragged hole through the abdominal wall one and one-half inches in diameter, and a soft bulging tumor just above the crest of the ilium behind.

Shot 4.—Load, new Schultze powder; thirty-nine grains, equivalent to three drachms of black powder. One and one-eighth ounces No. 7½ shot—what is known as a pigeon load.

Shot fired at the thoracic wall near the nipple; distance, eighteen feet. Spread of shot over an area six inches in diameter. A ragged hole one and one-half inches in diameter in the thoracic wall. A good many of the shot passed through the thorax emerged from the back and embedded themselves in the barrel-staves behind.

Shot 5.—A shot was then fired through the thorax at a distance of six feet, from behind. There were no powder marks on the skin. The wound of entrance was but little larger than the caliber of the gun. The wound of exit was a slit three inches in length. Nearly the entire charge went through the thorax and embedded itself in the barrel behind, including a powder wad which was found wedged in between the barrel hoops. Fragments of lung and heart tissue were plastered on the barrel, and the wall of the room was extensively splattered with the same material.

While we all have realized from experience that a shotgun fired at close range produced great destruction of tissue, it was to me at least a surprise to find that at so great a range as thirty-five feet a considerable part of the shot held together sufficiently to produce the effect of a single missile.

Even at a distance of eighteen feet I should not have expected such a destructive effect from a charge of fine bird-shot.

A number of pistol-shots were then fired with a litten handkerchief as a target; a piece of woollen cloth was then used, and then some squares of cardboard. The distances were three inches, and one foot.

It is to be noted that the smokeless powders produced only very slight discolorations of the linen cloth even when fired at a distance of three inches; upon woollen cloth no effect was produced appreciable by the eye, except a faint dark stain around the edge of the bullet hole. Some differences are to be noted between the effects produced on linen by the Colt's and the two German pistols.

The Colt cartridges are loaded with a green granular powder, probably Walsrode. This powder produces a faint speckled discoloration, which when examined closely is found to consist of a moderate number of rather large, brownish-black grains, adherent to but not deeply embedded among the fibres of the flax. No scorching effect can be detected. Under a microscope, these grains resemble the fused masses of slag from a smelting furnace.

The Mauser and Luger pistols are loaded with a powder which consists of thin squares of a dark grayish-black color, evidently cut from a sheet of the material from which the powder is made. I have been unable to learn the name of this powder, but it closely resembles the powder known as Ballistite in appearance, although the squares are smaller. These powders produced a faint grayish smudge upon the linen cloth at a distance of three inches. No distinct grains can be distinguished with the naked eye.

Under the microscope the discoloration is seen to consist of numerous fine black angular grains embedded among the meshes of the flax fibres; the grains are about equal in diameter to a single fibre of flax, and their distribution is quite different from that noted with Walsrode powder; the grains are also much smaller and more numerous.

The changes produced in linen by black powder are quite different.

At a distance of three inches the cloth was set on fire around the margin of the bullet hole. The cloth was scorched and discolored over an area more than three inches in diameter, and numerous powder-grain marks are scattered over the scorched area. Under the microscope these marks are found to be due to the presence of a large amount of brownish-black granular material plastered on the surface of the flax bundles. The scorching of separate bundles of fibres is also quite evident.

When fired at cardboard the same differences are to be noted between black and smokeless powders. The black powder causes scorching of the paper at very short distances (three inches), together with numerous marks of powder grains driven into the paper. At the distance of one foot the scorching is absent, but the powder grains are still very numerous and black. The smokeless powders fired at three inches cause slight smudging of the paper and numerous little indentations of the surface of a gray color .

The Mauser cartridges cause more discoloration of the paper and fewer indentations than the Colt.

At a distance of one foot the Mauser produces scarcely any perceptible mark, and the Colt produces a few slight indentations and no discolorations.

Although these experiments are few in number and by no means complete, a few conclusions may I think be drawn from them.

1. Powder marks upon the skin and clothing produced by smokeless powder are much less distinct and definite than those caused by black powder.

2. With the weapons used in these experiments, such marks cease to be produced when the distance exceeds one foot and the shot is fired at the naked skin.

3. At a distance of three inches or less powder marks may be present, but they will always be faint, and may in many instances be wiped away from the skin with a wet or dry cloth.

4. If the shot be fired at a part of the body covered with clothing, no powder marks at all will be found upon the skin. The clothing will never be scorched, no matter how near the weapon is held.

If the clothing be wool, no powder mark is likely to be detected upon it even at the closest range, unless under the microscope. If the clothing be of linen, a faint mark may be found upon it if the weapon were held at a distance of three or four inches or less. If the distance much exceeded this no mark would be produced.

The evidence furnished by a microscopic examination of the pieces of linen appears to me to be quite interesting.

It is evident that by this means it might in certain instances be possible to state with some positiveness that a certain kind of ammunition had or had not been used.

Such a conclusion might be of the greatest importance from a medicolegal stand-point.

Further experiments of this character with many different varieties of powder would, I think, be worth while.